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Lumber Recovery of Douglas-Fir From the Coast and Cascade Ranges of Oregon and Washington

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Abstract

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This report summarizes the results of lumber recovery studies at four sawmills in western Oregon and western Washington; two dimension mills, one grade mill, and one timber mill were included. Results from individual mills are reported and discussed. The four mills were also combined to approximate "average" conversion of logs to lumber for the region. Recovery information is presented by diameter and log grade for lumber volume, lumber grade, and lumber and log value.

Keywords: Douglas-fir, *Pseudotsuga menziesii*, lumber recovery, lumber yield, Oregon, Washington.

Summary

This report summarizes the results of lumber recovery studies at four sawmills in western Oregon and western Washington; two dimension mills, one grade mill, and one timber mill were included.

Volume recovery differed by log diameter, among mills, and by the units used to measure both logs and lumber, and may differ by whether the logs are measured as they come from the woods or after they have been bucked to mill lengths. Regression curves of recovery ratio, lumber recovery factor, or cubic recovery percent are plotted for both woods-length and mill-length logs. The cubic recovery percent for the combined mills reached about 76 percent of the log volume for logs greater than 20 inches. Recovery ratio ranged from 225 to 130 percent across diameter.

Two types of values are presented: value of the lumber and value of the log. Lumber value is determined by mill type and market conditions; the decision to cut for dimension, clears, or timbers depends on the market at the time of cutting, the expected grade recovery, and the expected cost of each alternative. Log value is the combination of both lumber grade and volume recovery. Although the four mills showed marked differences in grade and volume recovery, all the mills got about the same value from logs of similar size and grade. Log values are shown on both a board-foot and a cubic-foot basis across diameter for each of the log grades.

An analysis to determine if a difference could be found between young growth and old growth was done for all mills combined and on each individual mill. No differences were found between old-growth and young-growth logs for volume or value.

Contents

Introduction

Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) is one of the most important raw material resources in the United States. Nearly two-thirds of all lumber produced in the coast region of the Pacific Northwest and over half of the logs and lumber exported from Oregon and Washington are Douglas-fir (Warren 1986). The species is used for standard dimension lumber, export and domestic clears, and a significant volume of timbers. Specialty items include crossarms, scaffold plank, laminating stock, stepping, decking, flooring, car stock, tank stock, and so on. Veneer or plywood use is equally complex with over 30 grades of plywood being made in a variety of thicknesses.

The last comprehensive lumber or veneer recovery reports on coast Douglas-fir were published in 1973 and include data from recovery studies conducted in the 1960's (Lane and others 1973a, 1973b). Since the 1960's, product standards, mill equipment, and the size and quality of the resource have changed; updated information is therefore needed by land managers, timber appraisers, and mill owners.

The Timber Quality Research project at the Pacific Northwest Research Station, with the help of other public agencies and the forest products industry, has recently completed an extensive study of Douglas-fir in western Oregon and Washington. The study obtained yields of lumber and veneer from over 700 trees selected from typical commercial sawtimber stands throughout the Coast Range and west side of the Cascade Range of Oregon and Washington. For logistic reasons, the study was divided into two parts: the first part was completed in Oregon in 1981, and the second part was completed in Washington in 1983. Each part included three mills (two sawmills and a veneer plant) and manufactured trees sampled within each State. The veneer recovery information is being prepared as a separate report.

Objectives

Objectives of our study were to provide estimates of recovery of lumber volume, grade, and value by log diameter and log grade for mills sawing a variety of product lines, and to compare the volume and value recovery between old growth and young growth.

Field Procedures

Sample

Douglas-fir ranges from northern California to British Columbia and from sea level to elevations over 5,000 feet. The geographical area of our study was from the crest of the Cascade Range to the Pacific coast from the California-Oregon border north to the Mount Baker-Snoqualmie National Forest in northern Washington. To assure adequate sampling of the geographic diversity, western Oregon was divided into three areas and western Washington into four areas. Twenty-three areas were sampled from six National Forests and five Bureau of Land Management districts in Oregon; 22 areas were sampled from three National Forests in Washington (fig. 1).

The sampling procedure was designed to select a sample representative of the variation in the resource, **not** to represent the average size and quality of timber or the average log mix that a mill uses in a normal production run.

Figure 1—Approximate location of the 45 areas from which sample trees were selected.

Both old-growth and young-growth trees were included in the sample. Young-growth trees were defined as less than 100 years old (Lane 1973a). This coincides with the definition by the Old-Growth Definition Task Group (1986) of young-growth forests maturing at 80 to 110 years. The old-growth trees came from both mature and old-growth forests. The sample for old-growth timber was stratified by d.b.h. (diameter at breast height), quality, and defect. D.b.h. ranged from 12 to 50 inches and was divided into 4-inch classes for stratification. Quality was defined by the four-grade system (Lane and Woodfin 1977) applied to the first 16 feet of the tree. Defect was defined for stratification as the presence or absence of obvious defect indicators such as conks, defective scars and burls, or old breaks within the merchantable stem. The young-growth sample was stratified only by d.b.h.

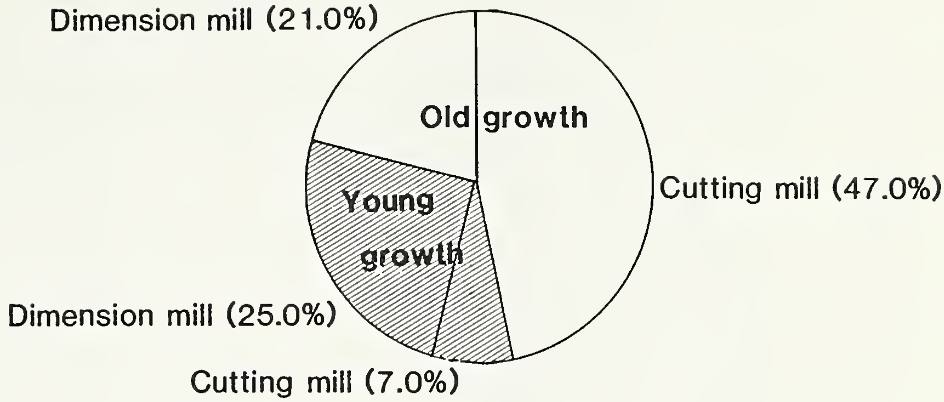

Figure 2—Percentage of Douglas-fir trees in each age class designated to be cut at each type of mill. Young-growth trees made up only 32 percent of the total sample but comprised over half of the volume sawn at the dimension mill.

After the sample was selected, trees were randomly sampled within each diameter and grade class for processing at specific mills. The following plan was designed to split the sample among the various mills based on log sizes normally processed at each mill. About one-fourth of the trees greater than 18 inches d.b.h. went to the veneer plant. Of the remaining trees, those less than 20 inches d.b.h. and half of the trees between 20 and 32 inches went to the dimension mills, and trees larger than 32 inches and the other half of the trees between 20 and 32 inches went to the cutting mill. Because of the diameter limitations, a relatively small proportion of young-growth timber was sawn at the cutting mills, but over half of the timber sawn at the dimension mills was young growth (fig. 2).

Trees designated for a particular mill were marked before logging so that the logs could be bucked to the lengths each mill preferred for their production.

Felling and Bucking

Trees were felled according to normal industry practices and bucked into the lengths preferred by each mill. Each tree was cut for the designated mill to a minimum top diameter of 5.6 inches. Logs were tagged to identify tree number, log position in the tree, and the mill it was intended for. Figure 3 shows the percentage of logs that were bucked into various lengths for each mill. No two mills preferred the same woods-length and mill-length logs. Two mills preferred 40-foot logs in the woods, but one bucked them into 20-foot sawmill lengths and the other mill bucked them into a mixture of 16-, 20-, and 24-foot lengths. Even the two mills that bucked about the same percentage of 20-foot mill-length logs did not buck the same woods-length logs.

Log Scaling and Grading

After all the logs were removed from the woods, a rollout scale of logs "as presented" was taken (table 1). Both Scribner (Northwest Log Rules Advisory Group 1980) and cubic[1] scales were taken. After the logs were bucked into sawmill lengths (table 2), they were rescaled using Scribner rules, as above, and a gross cubic scale was generated using the Scribner diameters and lengths. The logs were regraded after being bucked into sawmill lengths by using the seven-grade system (Northwest Log Rules Advisory Group 1980). We did not find any No. 1 Sawmill logs.

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[1] Unpublished administrative report, 1978, "The Draft Cubic Log Scaling Handbook," by the National Cubic Measurement Committee, U.S. Department of Agriculture, Forest Service, Washington, DC. 206 p.

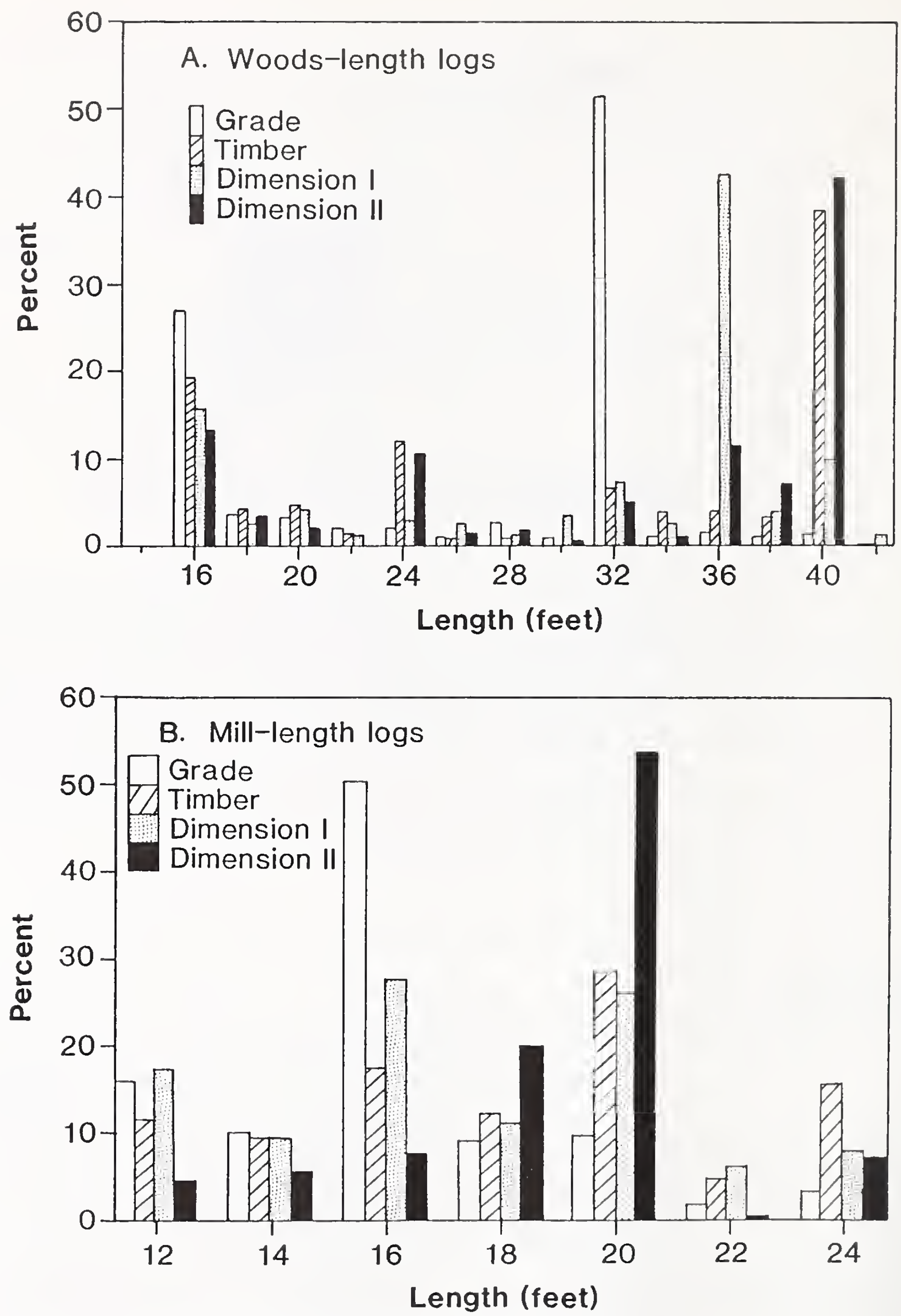

Figure 3—Percentage of total number of logs cut to various lengths for each mill. **A.** This figure shows that out of the four mills only two cut the same log lengths in the woods: the timber mill and dimension II. **B.** Although two mills bucked 40-foot logs in the woods, one mill bucked them into 20-foot mill lengths and the other mill bucked them into a mixture of 16-, 20-, and 24-foot mill lengths.

Table 1—Number of woods-length logs by diameter and log grade

Scaling diameter	Log grade					
	No. 1 Peeler	No. 2 Peeler	No. 3 Peeler	Special Peeler	No. 2 Sawmill	No. 3 Sawmill
Inches						
<6						57
6						237
8						202
10						230
12					162	34
14					172	17
16					149	23
18				25	101	14
20				28	78	11
22				29	59	7
24			23	3	32	6
26			27		31	3
28			34		19	3
30	1	5	26		16	1
32	2	10	18		11	2
34	7	9	11		5	
36	4	4	10		1	
38	2	4	7			
40	2	1	2		1	
42	1		1			
Total	19	33	159	85	837	847

Table 2—Number of mill-length logs for each log grade and diameter class

Scaling diameter	Log grade					
	No. 1 Peeler	No. 2 Peeler	No. 3 Peeler	Special Peeler	No. 2 Sawmill	No. 3 Sawmill
Inches						
<6						77
6						221
8						275
10						321
12					292	34
14					309	12
16				76	240	18
18				74	187	15
20				77	158	3
22				64	131	6
24			40	25	82	
26			52	11	67	1
28			56	10	45	1
30		9	47	3	38	
32		10	42	2	19	1
34	1	9	37		18	1
36	2	11	16		9	
38	2	5	12		3	
40	1	2	4		2	
42	2	2				
Total	8	48	306	342	1600	986

Sawing

As mentioned above, two types of mills were used in our study: dimension mills and cutting mills. Dimension mills produce primarily 2-inch dimension lumber in the light framing grade (Western Wood Products Association [WWPA] 1977, Section 40) and structural joist and plank grade (WWPA 1977, Section 62). The lumber is scant-sawn and volume recovery is normally quite high, but average lumber value is lower than at cutting mills. Cutting mills usually saw high-quality logs to produce domestic and export clears, timbers, and specialty items with the rest of the log going to dimension lumber. The preferred items are usually full-sawn so volume recovery in board feet is low but average sales value is high.

Four mills are included in this report, a dimension and a cutting mill in Oregon and a dimension and a cutting mill in Washington. Rough green lumber sizes and saw kerfs are given in table 3 in the appendix. The two dimension mills cut basically the same products and sizes (over 75 percent Standard and Better lumber and over 70 percent 2-inch lumber), although they had different equipment and mill layouts. The first dimension mill (dimension I) had a single-cut bandsaw headrig, a chipping edger, a twin-band resaw, a battery edger, a trimsaw, and a linebar resaw. The second dimension mill (dimension II) had a single-cut slant bandsaw headrig, a horizontal resaw, an optimizing bull edger, a sash-gang saw, a nonoptimizing bull edger, a trimmer, and a vertical resaw. Dimension II primarily live-sawed the logs, particularly the small-diameter logs; dimension I used the more conventional cant-sawing method.

The two cutting mills sawed more diversified products and sizes. The first cutting mill (grade mill) had a chipping slabber, single-cut bandsaw headrig, a bull edger, a twin band resaw, a trim saw, and a linebar resaw. The second cutting mill (timber mill) had two headrigs (a single-cut vertical bandsaw for large logs and a single-cut horizontal bandsaw for small-diameter logs), a bull edger, a twin-band resaw, and a trim saw. The grade mill sawed for grade with heavy production of 3 by 12 and smaller pieces. The timber mill live-sawed the small logs into dimension lumber and produced a large percentage of 6 by 6 and wider timbers from the large logs. A more detailed comparison of the average production of the two cutting mills is given in the following tabulation.

Item	Cutting mills	
	Grade	Timber
	(Percent)	(Percent)
Lumber thickness:		
2 inches	59	40
3 inches	23	—
4 inches	13	25
6 inches and thicker	5	35
Lumber grade:		
Selects	16	8
Standard & Better	66	85
Utility	15	5
Economy	3	2

The logs were processed through each sawmill, and each piece of lumber was identified from the log to the final shipping tally (rough green, surfaced green, or surfaced dry). The data were compiled into a computer output showing the amount and grade of lumber produced for each log along with the corresponding log-scale information. All lumber was graded under the supervision of an association grade inspector (WWPA, WCLIB [West Coast Lumber Inspection Bureau], or PLIB [Pacific Lumber Inspection Bureau]) using either of the two sets of published lumber grades (WWPA 1977, WCLIB 1970).

Lumber Pricing

The prices used in this report are average prices for Douglas-fir lumber from coast mills in 1985 (Warren 1986). These prices are from WWPA, which includes the entire range of lumber sizes and mills, and therefore should reflect the market at the time of the study. The prices used are:

Lumber grade	Price
	(Dollars per thousand board feet)
C Select	671.46
D Select and Shop	409.79
Structural Items	248.70
Heavy Framing	226.08
Light Framing	190.04
Utility	130.79
Economy	67.63

Lumber Grades

The lumber grades have been combined into groups based on sales and pricing information. The groupings are:

Grade group	Includes	Volume in study
		(Percentage)
Selects	B Select, C Select, D Select	4
Structural	Select Structural, Lam stock, Scaffold plank	17
Construction	Construction, No. 1	27
Standard	Standard, No. 2	38
Utility	Utility, No. 3	10
Economy	Economy	4

Analysis

The main purpose of this paper is to provide estimates of the recovery of lumber volume, grade, and value from Douglas-fir logs sawn at various mills. A secondary purpose is to compare the recovery of young growth to old growth.

The variables to be analyzed are the standard measures of recovery: volume of lumber, grade of lumber, and value of lumber or logs. The major sources of variation that were analyzed are log diameter, log grade, and mill technology and product line. Both woods-length and mill-length logs were analyzed, and log grades were compared to determine if they are separating the logs into distinct value classes. An analysis was also done to determine if a common estimate of lumber volume, grade, or value is appropriate over all mills.

Standard regression techniques were used, and the best model form for each dependent variable was chosen by using the coefficient of determination (R^2) and standard error of the estimate as criteria. Separate regression equations were estimated for each mill and log grade, and a covariance analysis or analysis of variance was done to test for differences among mills or among log grades. All tests were done at the 0.05 probability level.

Volume

Recovery of lumber volume will be expressed in three ways: recovery ratio (overrun), lumber recovery factor (LRF), and cubic recovery percent (CR%) based on rough-green lumber. Recovery ratio, LRF, and CR% were used as dependent variables with diameter and transformations of diameter ($1/D$, $1/D^2$) as independent variables.

Model forms tested were:

$$\begin{aligned}
\text{Volume} &= b_0 + b_1 D, \\
&= b_0 + b_1 1/D, \\
&= b_0 + b_1 D + b_2 1/D, \\
&= b_0 + b_1 D + b_2 1/D^2, \text{ and} \\
&= b_0 + b_1 D + b_2 1/D + b_3 1/D^2.
\end{aligned}$$

Volume recovery should not differ by log grade (Ernst and Pong 1985, Lane and others 1973a); log grades were therefore not used in the analysis of volume. Because both lumber volume and log volume are measured in cubic feet, CR% gives the most accurate representation of lumber to log volume relations (Fahey and Snellgrove 1982). Therefore, CR% was used to test for differences in volume among mills.

Value

Value will be expressed in three ways: $/MLT (dollars per thousand board feet of lumber tally), $/CCF (dollars per hundred cubic feet of log scale), and $/MNLS (dollars per thousand board feet of net log scale). Recovery of lumber value should differ by log grade and diameter; regression equations were therefore estimated for each log grade for each mill. The same model forms were tested for both volume and value.

Because $/MLT is the average value of the lumber produced and does not include bias due to defect estimation, it is a good indicator of the inherent quality of the wood. It was used to test whether the log grades separated the logs into distinct value classes. Standard F-tests or analysis of variance tests were used to compare the regressions for the following log grades: No. 1 Peeler vs. No. 2 Peeler and No. 3 Peeler vs. Special Peeler grades for each mill. Analysis was also done to determine if the value was different among mills. First, each log grade was tested for differences among all mills combined, then the dimension mills were compared, and finally the cutting mills were compared.

Analysis of the $/CCF and $/MBF were based on only woods-length logs because that is the most common unit for buying and selling logs.

Volume by Grade

The intent of the analysis of the volume by lumber grade was to show general trends in the data and relations between log grades and lumber grade recovery. Because the percentage of volume in each lumber grade differs by log diameter, regression equations were estimated for each lumber grade group. The cumulative percentage of volume in a grade group (for example, Selects, Structural and Selects, and so on) was the dependent variable, and diameter and transformations thereof were the independent variables. A set of regression equations (one for each lumber grade group) was estimated for each log grade. Regressions were estimated for each grade group except Economy, which was assumed to be 100 minus the sum of the percentages of the other grade groups.

Old Growth vs. Young Growth

Regressions for volume recovery (recovery ratio, LRF, CR%) and value recovery ($/MLT, $/MNLS, $/CCF) were estimated for both old-growth and young-growth logs for each mill. These regressions were compared by using an F-test of intercepts and slopes.

Results and Discussion

Volume

Cubic recovery percent—Cubic recovery percent gives the most accurate representation of lumber-volume-to-log-volume relations because both volumes are measured in cubic feet (Fahey and Snellgrove 1982). CR% is used to compare and explain differences in recovery among the four mills as shown in figure 4 (also see tables 4 and 5). CR% differs depending on the mill equipment, sawing procedures, and products produced. The two mills with low recovery for logs less than 20 inches in diameter used live sawing techniques. In general, mills using live-sawing-with-full-taper techniques with horizontal saws had the lower recovery. The live-sawing method has the lowest volume recovery particularly for logs more than 16 feet long (Hallock and others 1976).

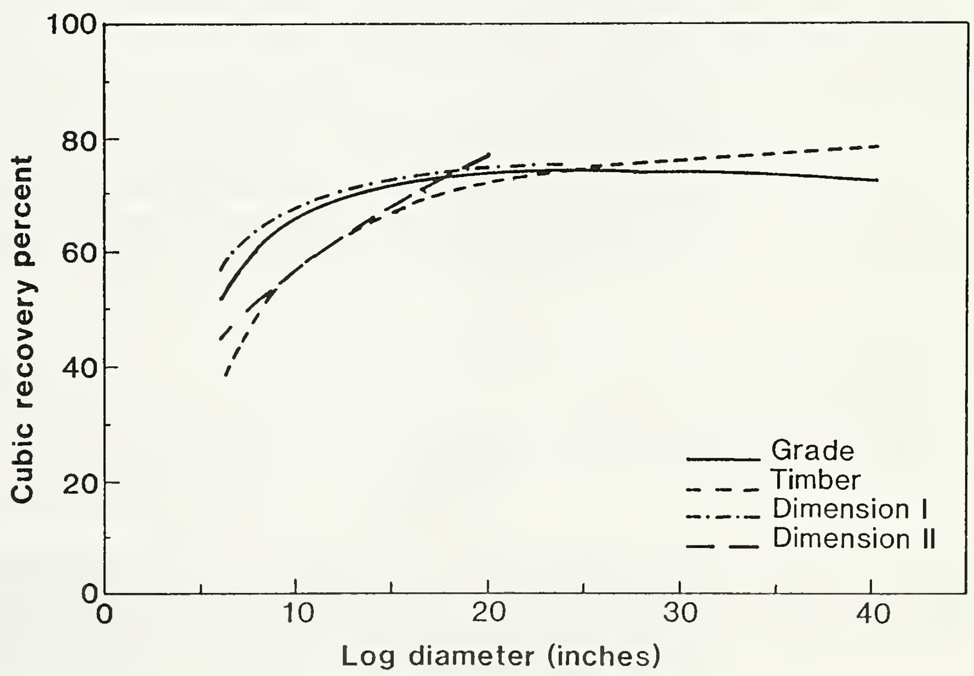

Figure 4—The relation of cubic volume recovery to log diameter for each mill is shown for mill-length logs. For logs less than 15 inches in diameter, the two mills with the lowest recovery were live-sawing the logs; the two mills with the highest recovery were cant-sawing the logs. For logs greater than 30 inches in diameter, the mill with the highest recovery was sawing for timbers and the mill with the lowest recovery was sawing for grade.

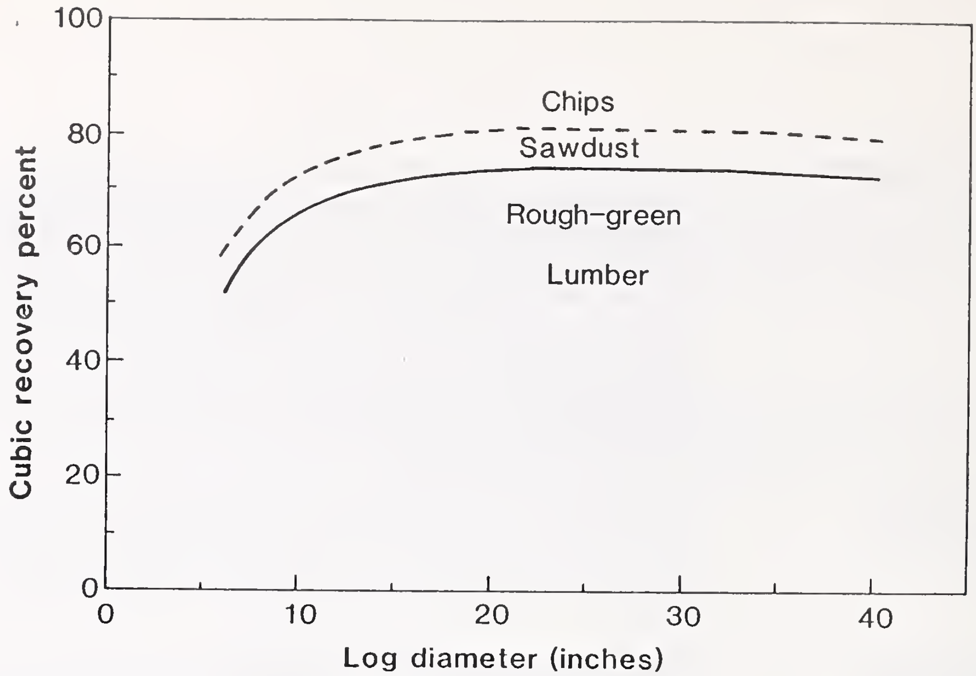

Figure 5—The cubic recovery percentages for rough-green lumber, sawdust, and chips are shown for the grade mill for mill-length logs. Cubic recovery percent of rough-green lumber rises to about 73 percent at 16 inches and remains fairly constant. The percentage of sawdust is not affected by log diameter; the percentage of chips is the complement of the percentage of volume of lumber and sawdust. The other mills would have similar recovery percentages of sawdust and chips.

Recovery for the logs larger than 20 inches in diameter is different because the cutting mills manufactured different products. The timber mill recovered more cubic feet of lumber because of fewer sawlines and less breakdown of the log. The grade mill recovered less lumber because it produced small pieces and did tighter trimming and edging to maximize the lumber grade.

Cubic recovery can also be used to estimate the volume of chips and sawdust produced during the conversion of round logs into rectangular lumber. Figure 5 shows the cumulative curves for rough-green lumber and sawdust for the grade mill as an example. The volume of sawdust was calculated by multiplying the surface area of the boards by one-half the saw kerf. The CR% of sawdust is about 7 percent of total log volume regardless of log size for the grade mill. The following tabulation gives the percentages of sawdust for the other mills:

Mill	Sawdust
	(Percent)
Grade	7.4
Timber	5.2
Dimension I	7.3
Dimension II	6.5

The percentage of the log volume that becomes chips or hog fuel is the complement of the CR% of lumber and sawdust and is calculated by subtracting the CR% of rough-green lumber and sawdust from 100. Separate recoveries for surfaced-dry lumber and planer shavings and shrinkage are not shown because the lumber in these studies was shipped in a variety of conditions—surfaced dry, rough green, rough dry, or surfaced green.

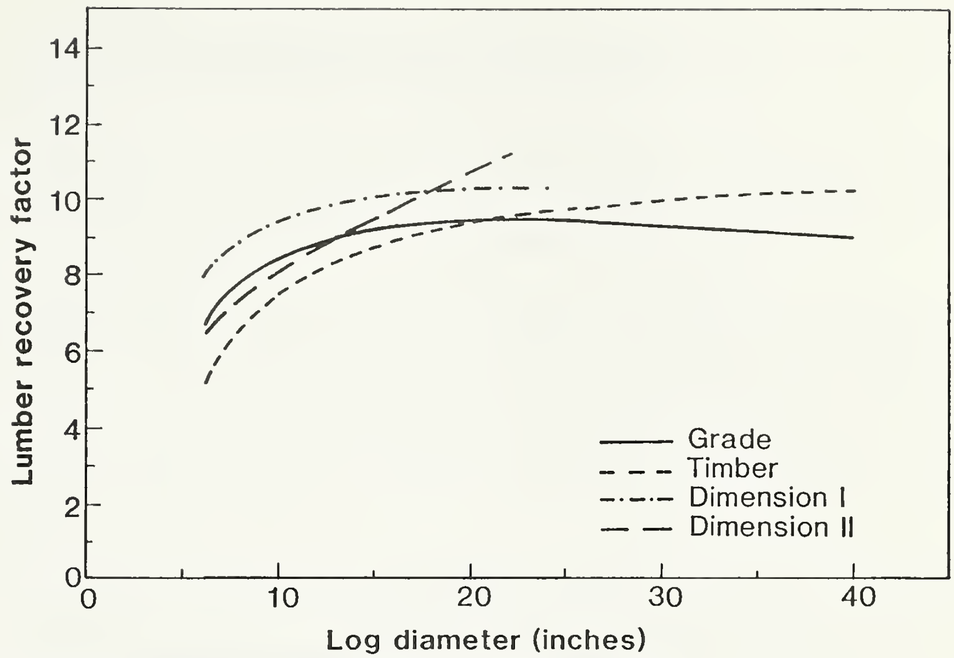

Figure 6—The relation of lumber recovery factor to log diameter is shown for each mill for mill-length logs. The LRF parallels the CR% except in the small diameters where the effect of using the board foot as a measure of lumber in the LRF increases apparent recovery at dimension mills.

Lumber recovery factor—LRF is the board foot volume of lumber divided by the cubic foot volume of the log. The LRF curves (fig. 6, tables 4 and 5) are similar to the CR% curves, but the difference in LRF between the dimension mills and cutting mills is greater. The dimension mills, which scant saw, produced more board feet of tally from a cubic foot of fiber than the cutting mills, which full saw.

Recovery ratio (overrun)—Recovery ratio is the most variable of the three estimates of lumber volume recovery. It is based on Scribner scale, which generally underestimates log volume by not recognizing log taper and typically overestimates the effect of defect.

Figure 7 (also see tables 4 and 5) shows the recovery ratios for woods-length and mill-length logs. The reason for the difference in the recovery ratio curves is that Scribner scale does not recognize the taper of the log. Because Scribner scale is based only on the diameter of the small end of the log, it underestimates the log volume. Bucking logs into shorter segments increases the total scale volume but decreases the recovery ratio.

Old growth vs. young growth—No statistical differences were found in any of the volume estimates between old-growth and young-growth logs for three of the mills; the fourth mill had no practical differences within the range of the data (5-22 inches).

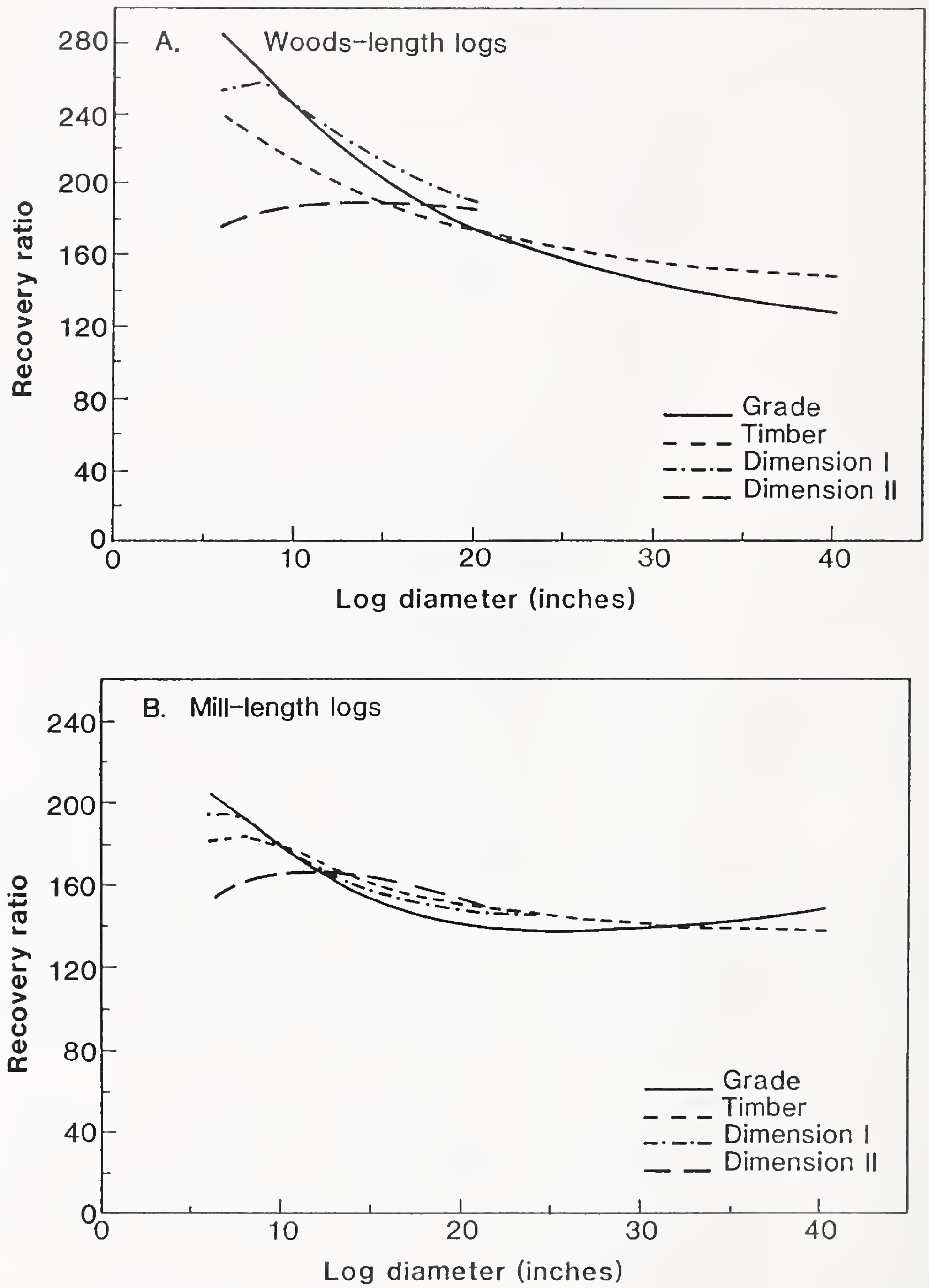

Figure 7—The relation of recovery ratio based on both woods-length (A) and mill-length (B) logs is shown over diameter for each mill. The recovery ratio is high for woods-length logs because Scribner scale does not include the effect of log taper in the volume estimation, and more volume is excluded on longer logs.

Old growth vs. young growth—No statistical differences were found in any of the volume estimates between old-growth and young-growth logs for three of the mills; the fourth mill had no practical differences within the range of the data (5-22 inches).

Value

Value is normally expressed as either value per unit of log scale or value per unit of lumber. The total value of each log is found by multiplying the volume of lumber in each grade by its price. The prices used to calculate the total log value were taken from Warren (1986) and are given in the section above, "Lumber Pricing."

Average lumber value—Because the average value of the lumber ($/MLT) is a good indicator of the inherent quality of the wood, it was used to test for differences in log grades. The $/MLT was estimated for each log grade for each mill. No statistical difference was found between No. 1 Peeler and No. 2 Peeler grades or between No. 3 Peeler and Special Peeler grades for any of the mills. Four log grades were therefore used for further analysis: No. 1 and No. 2 Peeler combined, No. 3 Peeler and Special Peeler combined, No. 2 Sawmill, and No. 3 Sawmill. (We did not find any No. 1 Sawmill logs.)

There was a significant difference in $/MLT between the grade mill and the timber mill for all log grades. The dimension mills did not process any No. 1 or No. 2 Peeler grade logs and only processed 15 No. 3 Peeler and Special Peeler grade logs each. These logs were not different in $/MLT from the grade mill. All mills were significantly different in $/MLT for the No. 2 Sawmill grade logs. Finally, the $/MLT for the No. 3 Sawmill was not different for the dimension mills but was significantly different among the timber, grade, and combined dimension mills. Figure 8 shows the $/MLT for each mill and log grade. Regression equations, average lumber values, and related statistics are given in tables 6 and 14 in the appendix. These values do not reflect premium prices of long-length pieces or timbers or manufacturing costs of the different mill types and product lines.

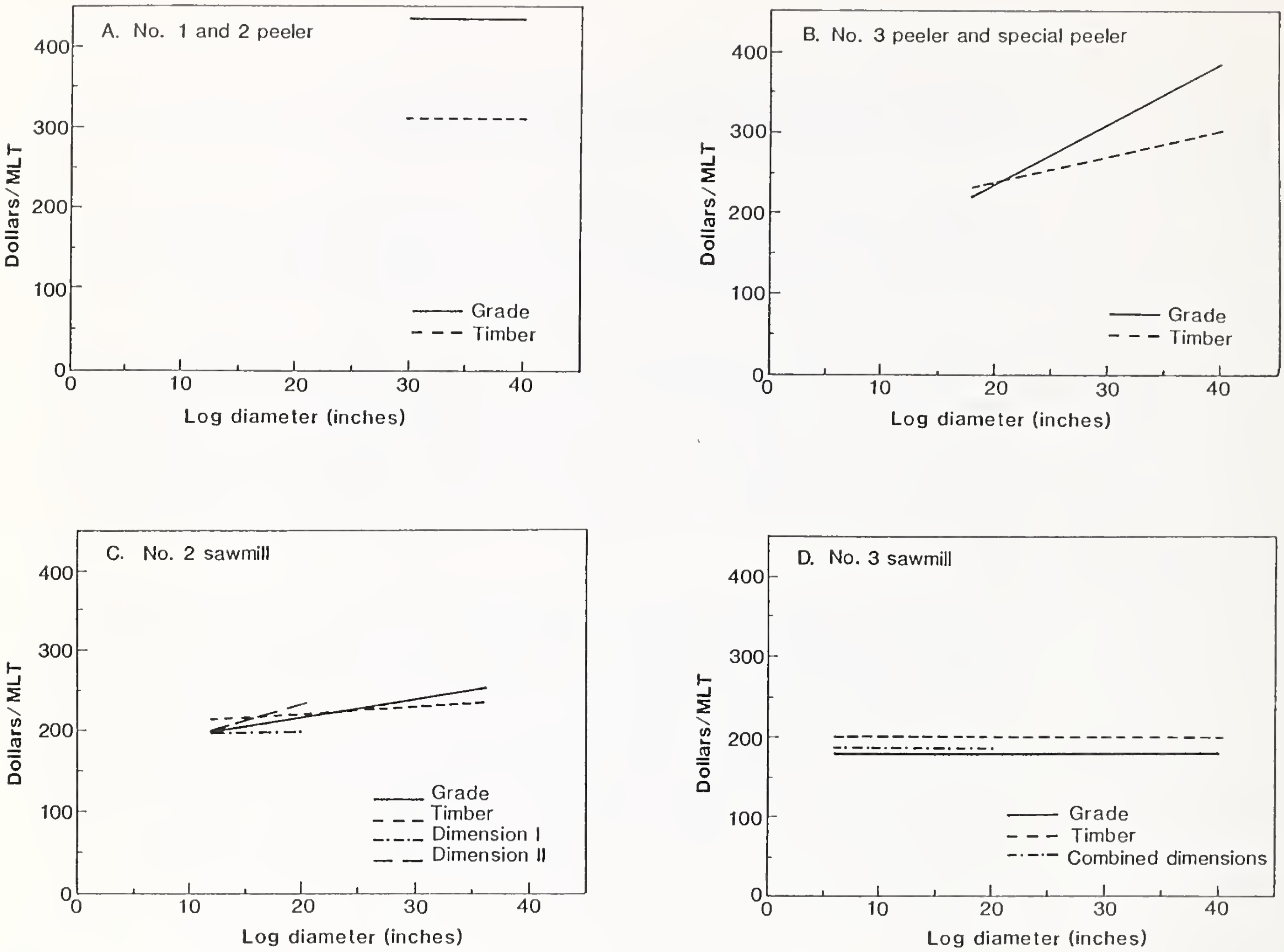

Figure 8—The average lumber value by log diameter and log grade is shown by diameter for each mill for mill-length logs. The $/MLT differed by log grade and in some cases differed by log diameter. Grade 3 Sawmill logs produced the same value lumber at the two dimension mills. With that one exception, each mill produced a different value for each grade of log.

Volume by lumber grade—The differences in value are caused by and can be explained by showing the proportion of lumber grades recovered in each log grade and mill. The difference in $/MLT for the No. 3 Peeler and Special Peeler grade logs will be used as an example. Figure 8b shows that the $/MLT is higher and increased more rapidly over diameter for the grade mill than for the timber mill. Figure 9 shows the related percentage of volume in each lumber grade for the grade and timber mills. The grade mill produced a much larger percentage of Select lumber and the increase in the proportion of Selects is directly related to the increase in $/MLT. The change in the percentage of Selects influences the $/MLT more than the other lumber grades because of the price differential between the Selects and the rest of the grades. The results are similar for woods-length logs and mill-length logs. The percentage of volume by lumber grade for each log grade and mill are given in tables 7, 8, and 9 in the appendix.

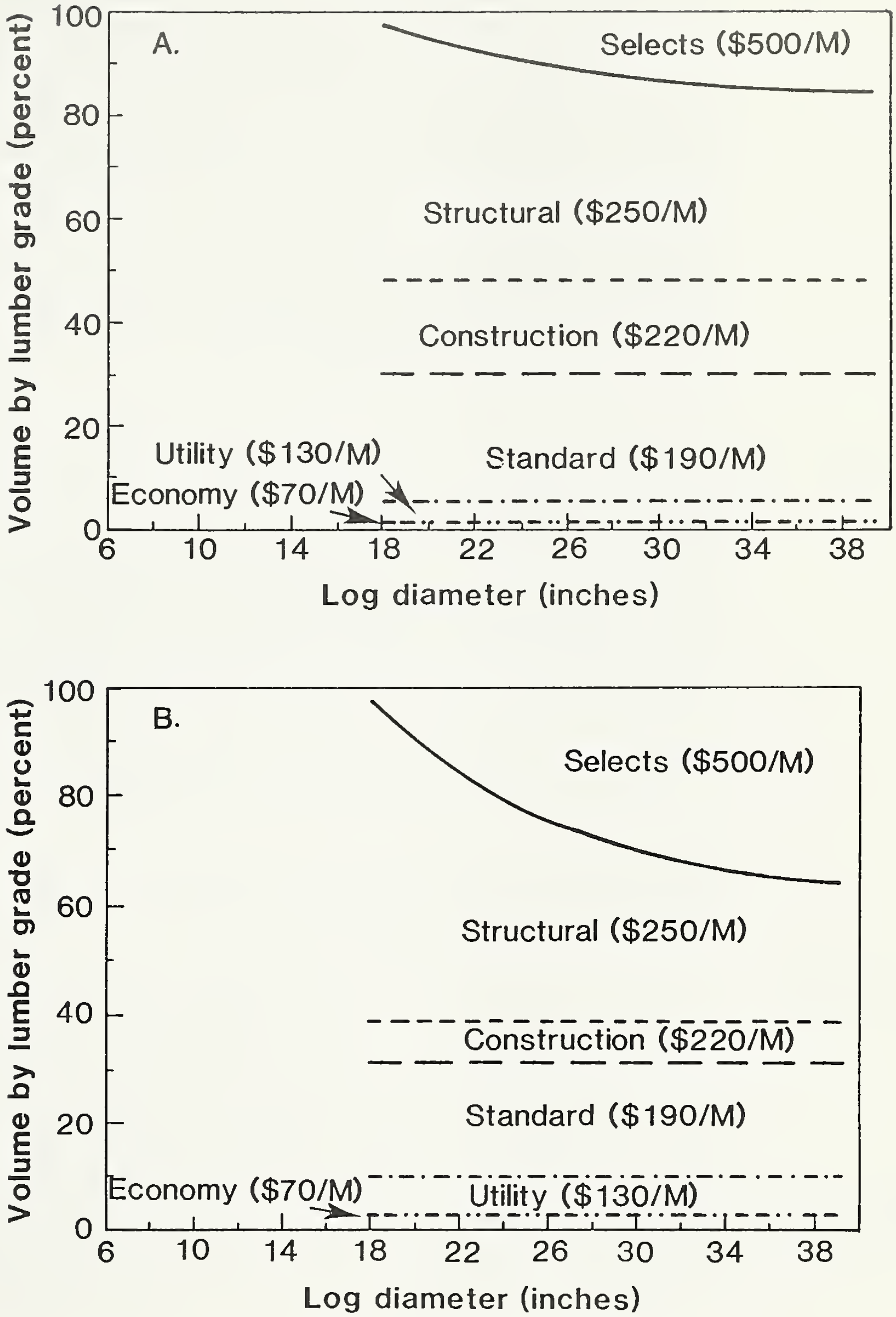

Figure 9—The percentage of volume produced in each lumber grade group by diameter is shown for the No. 3 Peeler and Special Peeler grade logs sawn at the timber (A) and grade (B) mills. Part B helps to explain the difference in the $/MLT. Although there are slight differences in the percentages of Construction, Standard, Utility, and Economy, major differences occur in the percentage of Structural and Selects. The Selects are priced at double the Structural price, and the grade mill produced almost twice as much volume in Selects, the average $/MLT is therefore higher for the grade mill.

Log value—The log value is the total lumber value divided by the net log volume; it reflects both the quality of the wood and the scaler's estimate of volume and defect. The log value is generally expressed as $/MNLS (dollars per thousand board feet of net Scribner scale) or $/CCF (dollars per hundred cubic feet of net scale). The log value can be found in two ways: (1) by multiplying the $/MLT times the appropriate volume recovery, or (2) by predicting log value directly. The first approach provides detailed information about volume recovery and lumber value recovery and makes repricing easier, but the log value estimates have a total variation that cannot be quantified (they are the multiplication of two undefined error terms) (Fahey 1983). The second approach provides the most accurate and statistically measurable estimates, but repricing can be more difficult. Repricing will be a problem, however, only if prices shift relative to each other; for example, if the price of Standard increases while the price of Selects remains constant. In that case, new regression coefficients must be estimated.

The following results are for both $/MNLS and $/CCF. The No. 1 and No. 2 Peeler log grade and the No. 3 Peeler and Special Peeler log grade values did not differ by diameter. Test for analysis of variance showed significant differences between the mills for the No. 1 and No. 2 Peeler grade, but no significant difference between the mills for the No. 3 Peeler and Special Peeler grade. Again, these values do not reflect premium prices for large timbers and lumber more than 20 feet long. The No. 2 Sawmill and No. 3 Sawmill did differ by diameter but were not significantly different among mills. No difference was found between young growth and old growth for either $/MNLS or $/CCF for any of the mills. The $/MNLS (fig. 10) differs by log grade and diameter, and it is affected by the inaccuracies of the scaling system. The $/CCF (fig. 11) is based on a more consistent measure of log volume and therefore shows a more distinct separation between log grades. The $/MNLS and the $/CCF for each log grade are given in table 10 in the appendix.

Old growth vs. young growth—No differences were found in $/MLT, $/MNLS, or $/CCF between young growth and old growth for any of the mills or log grades. Young-growth logs were graded only as No. 2 or No. 3 Sawmill.

Combination of Mills

Our intent in including this combination section was to provide a regionwide estimate of lumber recovery based on the combination of four sawmills. The four sawmills included two dimension mills that processed logs less than 25 inches in diameter and two cutting mills that sawed logs from 6 to 50 inches in diameter. One cutting mill sawed to maximize recovery of grade, and the other one sawed for production of timbers. The regression estimates for the combined mills are an average of these four mills. The estimates may not be representative of the actual production in the region, but they are the basis for recovery estimates currently being used by the USDA Forest Service to appraise Douglas-fir in Oregon and Washington.

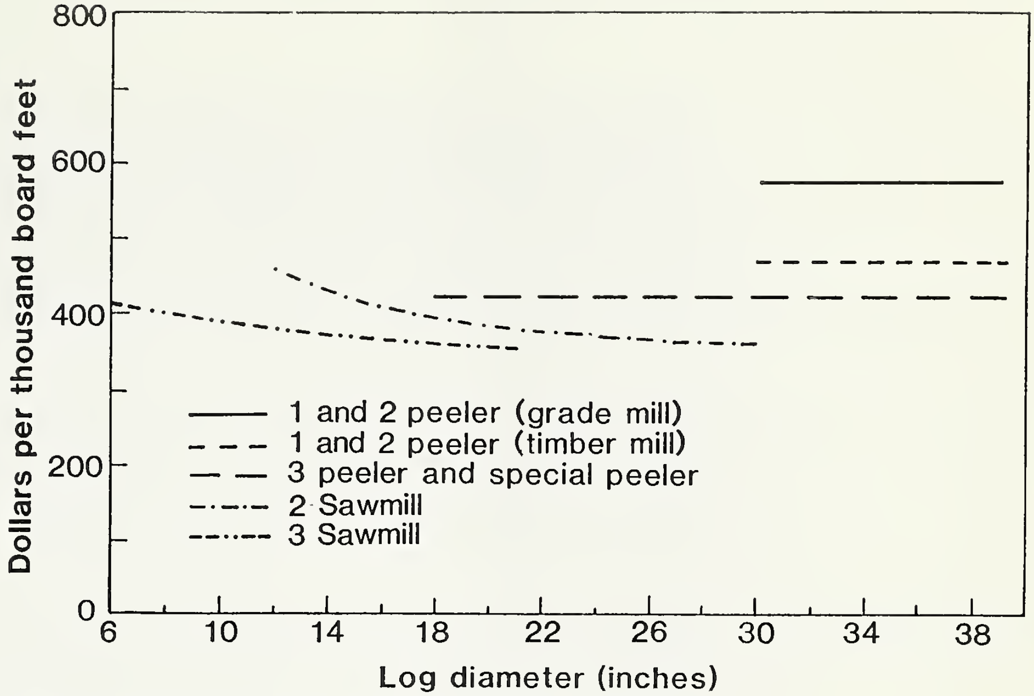

Figure 10—Average log value based on net Scribner scale is shown over diameter for each log grade for woods-length logs. This value combines the recovery ratio with the average lumber value. High recovery ratios and low $/MLT combined to produce the same log values as low recovery ratios and high $/MLT. The only significant difference was found between the grade mill and the timber mill for No. 1 and No. 2 Peeler logs.

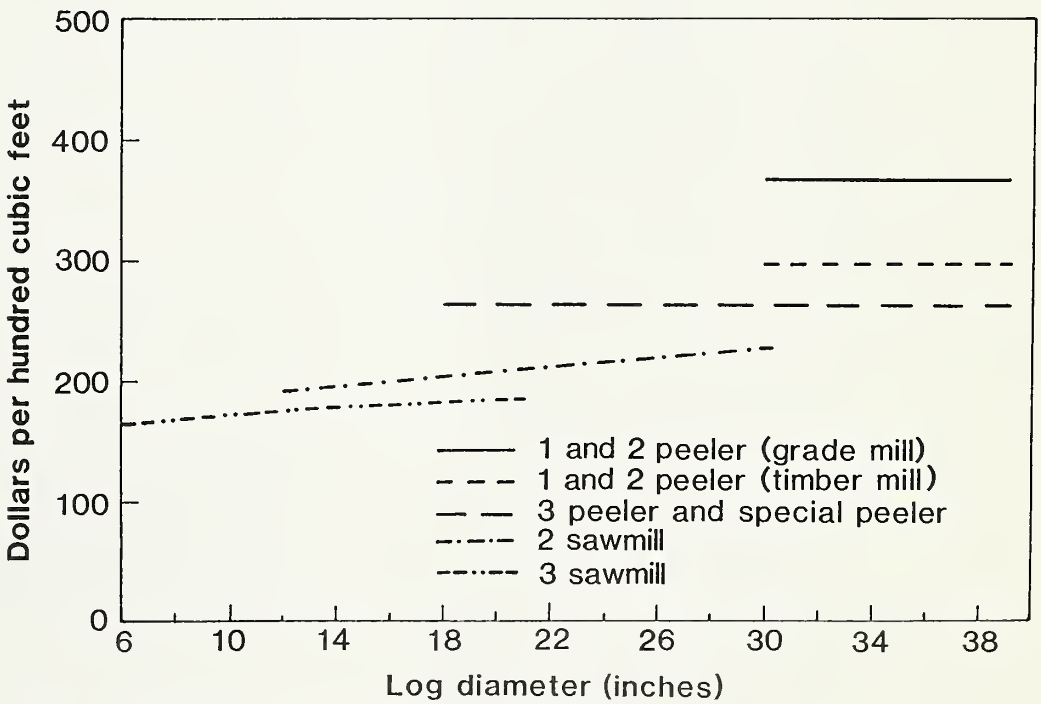

Figure 11—Dollars per hundred cubic feet of log volume is shown over diameter for each of the log grades for woods-length logs. The $/CCF combines cubic recovery percent and average lumber value. The differences between mills were the same as for $/MNLS, only the No. 1 and No. 2 Peeler logs produced significantly different values between the grade mill and the timber mill.

Volume—Figure 12 and table 11 show the volume recovery for both woods-length and mill-length logs. The CR% and the LRF are not practically different for different log lengths. The recovery ratio does differ with log length as previously discussed. In this study, the LRF is similar to the CR% curve, but the LRF decreases in the larger diameters. This is because the ratio of board foot to cubic volume of lumber is fairly consistent for small logs but decreases for large logs because a greater proportion of scant-sawn dimension lumber is produced from the small logs and a greater proportion of full-sawn clears and timbers are produced from the large logs.

Value—Figure 13 and table 12 show the $/MLT for the combined log grades with all mills combined. Distinct differences can be seen between the value of the log grades, which show that the log grades are effective in separating the logs by the quality of the wood they contain. The log values ($/MNLS and $/CCF) were different only for the grade and timber mills for the No. 1 and No. 2 Peeler grade logs, so a separate set of combined curves was not necessary.

Updating Values

Because all the value information is presented in 1985 prices, it may need to be updated. If the assumption is made that actual prices increase but the relative prices between lumber grades remain constant, the price information can be updated by calculating the percentage increase in prices and increasing the value predictions by that amount. The base price in this report is tied to a publication (Warren 1985) that is updated quarterly, so average values can be updated periodically. For example: a product worth $600 in 1985 may be worth $700 in 1987. The percentage increase is 700/600 = 1.17. If the $/CCF is $200 in 1985, then the $/CCF would be $200 * 1.17 = $233.33.

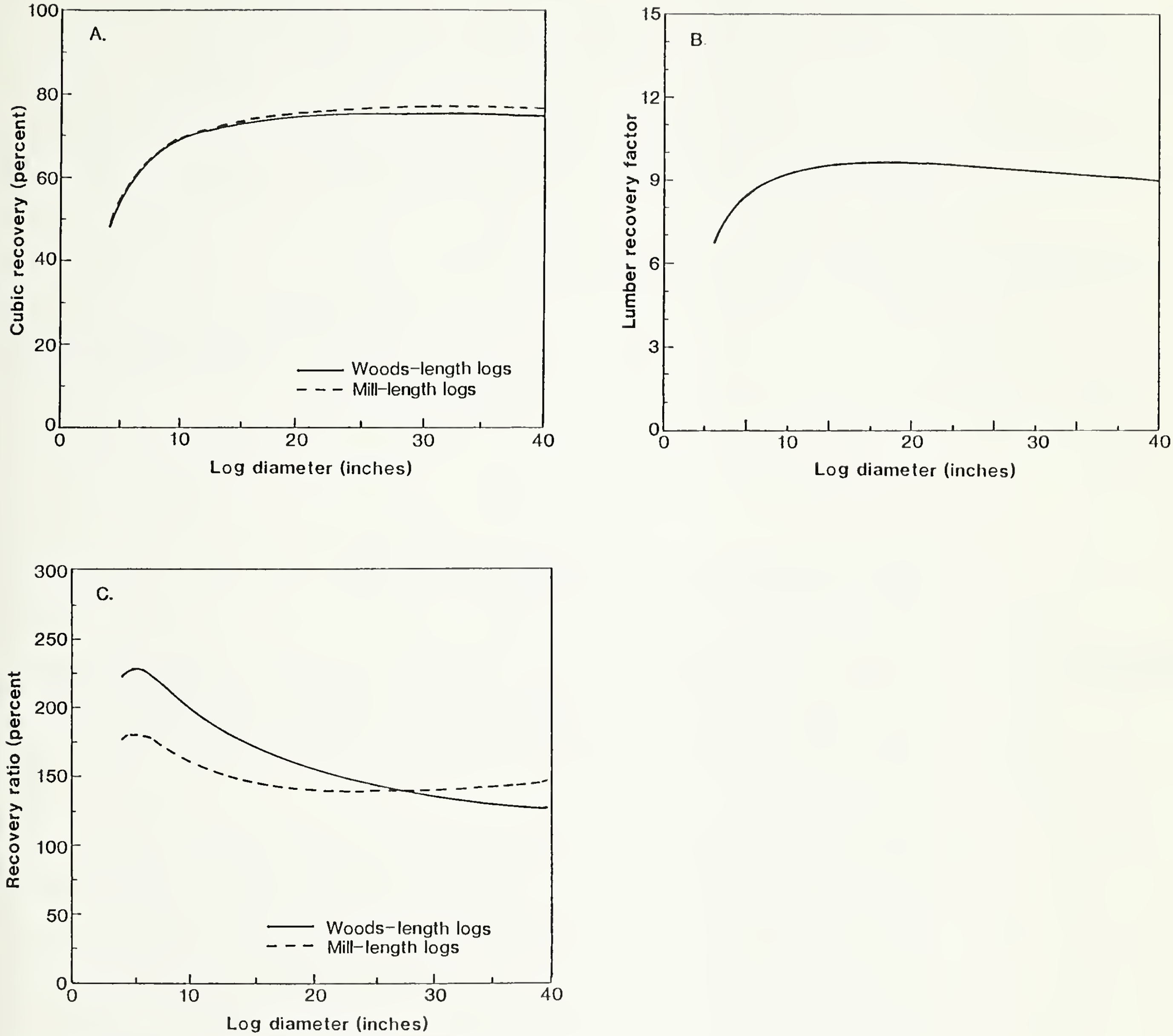

Figure 12—Volume recovery curves are shown for all mills combined for both woods-length and mill-length logs. **A.** Cubic recovery is slightly higher when recovery is estimated on mill-length logs. This difference is not of practical importance. **B.** Lumber recovery factor is not different for woods-length or mill-length logs. **C.** Recovery ratio based on board foot of Scribner scale differed widely between wood-length and mill-length logs. The use of only small-end diameters to calculate log volume and not accounting for taper are the main reasons for the difference.

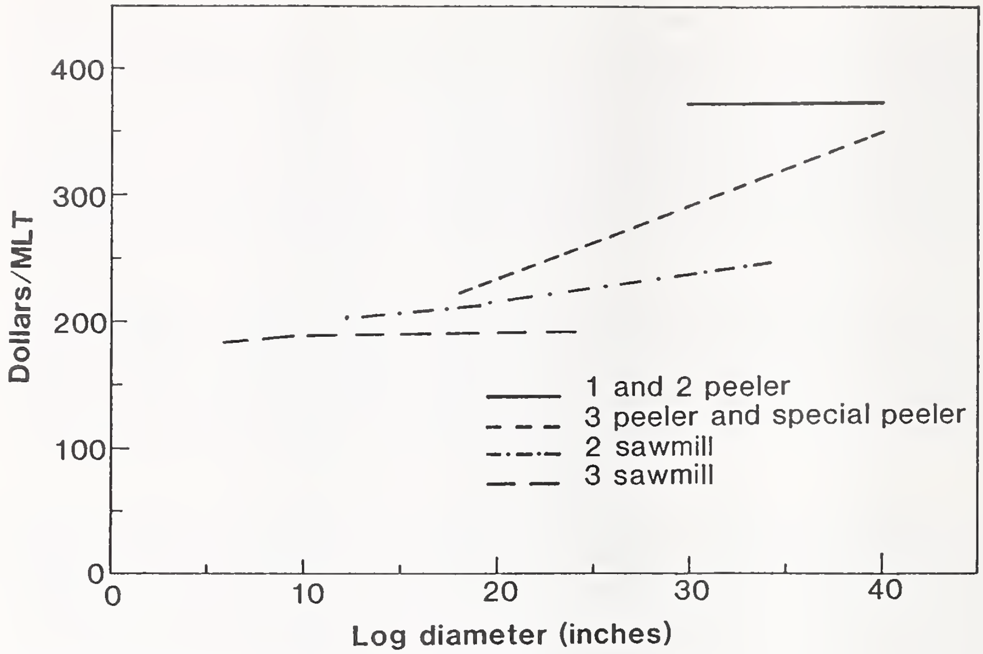

Figure 13—Average lumber value by log grade and diameter for mill-length logs for all mills combined. Average lumber value differs by log grade and may also differ by diameter within log grade.

Conclusions

Douglas-fir is manufactured into a wider variety of products than is any other species. Possible products range from small pieces of trim to the largest structural items. The volume, value, and type of products differ within and between mills and depend on both log size and mill type. The sheer number of choices available to mill operators makes Douglas-fir recovery difficult to characterize.

Recovery of lumber volume is a reflection of product line and the cutting strategy used by the mill. Cutting to maximize grade resulted in more sawlines and closer edging and trimming than sawing to maximize timber production. Live-sawing techniques produced lower recovery than cant sawing in small-diameter logs. Volume recovery differed by diameter and by the units used to measure both logs and lumber, and may differ by whether the logs are measured as they come from the woods or after they have been bucked to mill lengths. Regression curves of recovery ratio (board-foot measure of logs and lumber), lumber recovery factor (cubic-foot measure of logs and board-foot of lumber), or cubic recovery percent (cubic-foot measure of logs and lumber) are plotted for both woods-length and mill-length logs. The CR% for the combined mills reached about 76 percent of the log volume for logs greater than 20 inches. Recovery ratio ranged from 225 percent to 140 percent across diameter.

Two types of value are presented: value of the lumber and value of the log. Lumber value is determined by mill type and market conditions; the decision to cut for dimension, clears, or timbers depends on the market at the time of cutting, the expected grade recovery, and the expected cost of each alternative. Log value is the combination of both lumber grade and volume recovery. Although the four mills showed marked differences in grade and volume recovery, all the mills got about the same value from logs of similar size and grade. Log values are shown on both a board-foot and a cubic-foot basis across diameter for each of the log grades.

An analysis to determine if a difference could be found between young growth and old growth was done for all mills combined and for each individual mill. No differences were found between old-growth and young-growth logs for volume or value.

Acknowledgments

We thank Swanson Bros. Lumber Co., Inc., Noti, Oregon; Buse Lumber and Sales, Marysville, Washington; Seaboard Lumber Co., Seattle, Washington; and Davidson Industries, Mapleton, Oregon, for cooperating in these lumber recovery studies.

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Glossary

Cant sawing—The log is sawn with side lumber and cant in one plane, with the cant further broken down in a second plane perpendicular to the first.

Cubic recovery percent (CR%)—The cubic feet of lumber produced from a cubic foot of log input. Log volume can be expressed as a percentage of the gross, net (firmwood), or product (merchantable) cubic scale. Cubic recovery percent can be based on surfaced-dry as well as rough-green lumber.

Dollars per hundred cubic feet of log scale ($/CCF)—The total value of the lumber produced from a log divided by the cubic scale of the log. Cubic scale volume may be gross, net (firmwood), or product (merchantable).

Dollars per thousand board feet lumber tally ($/MLT)—The average value of the lumber produced based on the lumber produced and the pricing structure used in this paper.

Full sawn—Allows for no planer skip on any of the pieces.

Live sawing—The log is sawn with all sawlines in one plane (parallel).

Live sawing with full taper—The log is sawn with all sawlines parallel to one of the outside faces of the log.

Lumber recovery factor (LRF)—The board feet of lumber produced from a cubic foot of log input. As with cubic recovery percent, log input volume can be gross, net (firmwood), or product (merchantable) cubic scale.

Recovery ratio (overrun)—The board feet of lumber produced from a board foot of net log scale and expressed as a percentage. In some cases, overrun and recovery ratio are used interchangeably. Technically, overrun is the board feet of lumber minus the net log scale, divided by the net log scale and expressed as a percentage, or the recovery ratio minus 100.

Scant sawn—Allows for planer skip on about 5 percent of the pieces.

Appendix

Tables 3-15

Table 3—Actual sizes in inches of rough-green lumber and saw kerf for each mill

	Mill			
Nominal size	Timber	Grade	Dimension I	Dimension II
Thickness:				
1	0.870	1.061	1.092	0.969
5/4		1.328		
2	1.848	1.831	1.685	1.745
9/4			2.083	
10/4	2.580			
3	2.847	2.801	2.774	
4	3.823	3.844		3.802
6	5.852	5.865		5.845
8	7.774	7.886		
12	11.801			
Width:				
2	1.877	2.061	2.033	
3	2.860	2.896	2.990	2.750
4	3.815	3.990	3.879	3.750
5		4.953		
6	5.830	5.972	5.964	5.812
8	7.783	8.019	7.897	7.750
10	9.773	9.938	9.873	9.812
12	11.801	11.943	11.830	11.750
14	13.801	13.962	14.806	13.875
16	15.834			
18	17.794			
Average saw kerf	0.150	0.160	0.150	0.150

Table 4—Volume recovery[a] expressed three ways for mill-length logs by diameter for individual mills

Diameter	Recovery ratio by mill: Grade	Timber	Dimension I	Dimension II	Lumber recovery factor by mill: Grade	Timber	Dimension I	Dimension II	Cubic recovery percent by mill: Grade	Timber	Dimension I	Dimension II
Inches	*Percent*								*Percent*			
6	203	181	196	152	7	5	8	6	52	38	57	45
8	192	183	192	161	8	7	9	7	61	50	64	51
10	178	177	180	166	8	8	9	8	66	57	68	57
12	166	170	169	167	9	8	10	9	69	62	70	61
14	157	164	161	165	9	9	10	9	71	66	72	66
16	150	159	154	162	9	9	10	10	72	68	73	70
18	145	154	150	158	9	9	10	10	73	70	74	74
20	141	151	147	152	9	9	10	11	74	72	75	78
22	139	148	146	146	9	9	10	11	74	73	75	82
24	138	145	145		9	10	10		74	74	75	
26	138	144			9	10			74	75		
28	138	142			9	10			74	76		
30	139	141			9	10			74	76		
32	140	140			9	10			74	77		
34	141	139			9	10			74	77		
36	143	139			9	10			73	78		
38	145	138			9	10			73	78		
40	148	138			9	10			73	79		

[a] Equations and related statistics are presented in table 13.

Table 5—Volume recovery[a] expressed three ways for woods-length logs by diameter for individual mills

Diameter	Recovery ratio by mill: Grade	Timber	Dimension I	Dimension II	Lumber recovery factor by mill: Grade	Timber	Dimension I	Dimension II	Cubic recovery percent by mill: Grade	Timber	Dimension I	Dimension II
Inches	*Percent*								*Percent*			
6	283	237	254	176	7	6	8	6	53	42	56	43
8	265	224	257	185	8	7	9	7	61	53	64	49
10	244	211	245	188	9	8	10	8	66	59	68	55
12	225	200	231	189	9	8	10	8	68	64	71	59
14	209	191	218	189	9	9	10	9	70	67	73	63
16	195	184	207	188	9	9	10	9	71	69	74	67
18	184	178	198	188	9	9	10	10	72	71	75	71
20	175	173	189	188	9	9	10	10	72	73	75	75
22	167	168			9	10			72	74		
24	160	165			9	10			72	75		
26	154	162			9	10			72	76		
28	149	159			9	10			72	77		
30	145	456			9	10			72	78		
32	141	154			9	10			71	78		
34	137	152			9	10			71	79		
36	134	150			9	10			70	79		
38	131	149			9	10			70	80		
40	128	147			9	10			69	80		

[a] Equations and related statistics are presented in table 13.

Table 6—Average lumber value by diameter[a] based on mill-length logs for each log grade and mill

Diameter	No. 1 and No. 2 Peeler		No. 3 Peeler and Special Peeler		No. 2 Sawmill				No. 3 Sawmill		
	Grade	Timber	Grade	Timber	Grade	Timber	Dimension I	Dimension II	Grade	Timber	Combined dimension
Inches	*Dollars*										
6-11									179	201	187
12					199	214	199	200	179	201	187
14					203	216	199	209	179	201	187
16					208	218	199	217	179	201	187
18			221	232	212	219	199	226	179	201	187
20			236	238	217	221	199	234	179	201	187
22			251	245	221	223			179	201	
24			266	251	226	224			179	201	
26			281	258	230	226			179	201	
28			295	264	235	228			179	201	
30	435	310	310	270	239	230			179	201	
32	435	310	325	277	244	231			179	201	
34	435	310	340	283	248	233			179	201	
36	435	310	355	290	253	235			179	201	
38-40	435	310	369						179	201	

[a] Equations and related statistics are presented in table 14.

Table 7—The percentage of volume in each lumber grade group with 95-percent confidence intervals, by diameter for each log grade, for the grade mill

Diameter	Selects	95-percent confidence interval	Structural	95-percent confidence interval	Construction	95-percent confidence interval	Standard	95-percent confidence interval	Utility	95-percent confidence interval	Economy
Inches					*Percent*						
					NO. 1 AND NO. 2 PEELER						
30-40	58	±7	13	±6	4	±4	15	±5	7	±4	3
					NO. 3 PEELER AND SPECIAL PEELER						
18	6[a]	[a]	49[a]	[a]	20[a]	[a]	19	±6	8	±6	0
21	14		42		17		19	±6	8	±6	0
24	21		36		15		19	±6	8	±6	1
27	26		31		14		19	±6	8	±6	2
30	30		28		13		19	±6	8	±6	3
33	33		25		12		19	±6	8	±6	4
36	36		22		11		19	±6	8	±6	4
39	38		20		10		19	±6	8	±6	4
					NO. 2 SAWMILL						
12	0[b]	[b]	16	±8	39[b]	[b]	37[b]	[b]	7[b]	[b]	0
15	1		16	±8	37		33		9		5
18	3		16	±8	35		30		10		7
21	6		16	±8	32		27		11		7
24	9		16	±8	30		26		13		7
27	11		16	±8	27		24		14		7
30	14		16	±8	25		23		15		7
33	17		16	±8	22		23		17		6
					NO. 3 SAWMILL						
6-27	1	±4	3	±5	25	±9	49	±9	16	±8	6

[a] The following are the regression equations and related statistics, including the 95-percent confidence intervals (CI) at the mean value of the independent variable (1/28 inches):

SELECTS = 65.55 - 1072.27/D $r^2 = 0.24$ $S_{y.x} = 0.61$ CI for D = 28 inches is ±2 percent

STRUCTURAL = -4.74 + 975.14/D $r^2 = 0.24$ $S_{y.x} = 0.45$ CI for D = 28 inches is ±2 percent

CONSTRUCTION = 2.14 + 315.01/D $r^2 = 0.06$ $S_{y.x} = 0.75$ CI for D = 28 inches is ±1 percent

[b] The following are the regression equations and related statistics, including the 95-percent confidence interval (CI) at the mean value of the independent variable:

SELECTS = -12.82 + 0.90*D $r^2 = 0.34$ $S_{y.x} = 1.59$ CI for D = 26 inches is ±1 percent

CONSTRUCTION = 49.12 - 0.81*D $r^2 = 0.06$ $S_{y.x} = 0.56$ CI for D = 26 inches is ±2 percent

STANDARD = 14.10 + 278.15/D $r^2 = 0.07$ $S_{y.x} = 0.51$ CI for D = 25 inches is ±1 percent

UTILITY = 2.07 + 0.44*D $r^2 = 0.03$ $S_{y.x} = 1.29$ CI for D = 26 inches is ±1 percent

Table 8—The percentage of volume in each lumber grade group with 95-percent confidence intervals, by diameter for each log grade, for the timber mill

Diameter	Selects	95-percent confidence interval	Structural	95-percent confidence interval	Construction	95-percent confidence interval	Standard	95-percent confidence interval	Utility	95-percent confidence interval	Economy
Inches					*Percent*						
					NO. 1 AND NO. 2 PEELER						
30-39	24	±6	31	±7	16	±6	24	±6	3	±3	2
					NO. 3 PEELER AND SPECIAL PEELER						
18	4[a]	[a]	47[a]	[a]	16	±6	27	±7	4	±4	2
21	7		45		16	±6	27	±7	4	±4	1
24	10		43		16	±6	27	±7	4	±4	1
27	12		40		16	±6	27	±7	4	±4	1
30	14		38		16	±6	27	±7	4	±4	1
33	15		36		16	±6	27	±7	4	±4	2
36	16		34		16	±6	27	±7	4	±4	3
39	17		31		16	±6	27	±7	4	±4	4
					NO. 2 SAWMILL						
12-33	2	±3	28	±9	21	±7	41	±8	6	±6	2
					NO. 3 SAWMILL						
6-27	1	±5	12	±9	23	±10	47	±10	11	±8	6

[a] The following are the regression equations and related statistics, including the 95-percent confidence interval (CI) at the mean value of the independent variable:

SELECTS = 28.97 - 457.47/D r^2= 0.17 $S_{y.x}$ = 0.73 CI for D = 25 inches is ±1 percent

STRUCTURAL = 60.55 - 0.75*D r^2= 0.06 $S_{y.x}$ = 0.37 CI for D = 26 inches is ±2 percent

Table 9—The percentage of volume in each lumber grade group with 95-percent confidence intervals, by diameter for each log grade, for the dimension mills

Diameter	Selects	95-percent confidence interval	Structural	95-percent confidence interval	Construction	95-percent confidence interval	Standard	95-percent confidence interval	Utility	95-percent confidence interval	Economy
Inches					*Percent*						
					NO. 2 SAWMILL						
Dimension I:											
12-22	3	±5	12	±7	34	±8	33	±7	15	±7	3
Dimension II:											
12	1	±3	21	±8	36 [a]	[a]	39	±8	4	±5	0
15	1	±3	21	±8	32		39	±8	4	±5	4
18	1	±3	21	±8	29		39	±8	4	±5	7
21	1	±3	21	±8	26		39	±8	4	±5	9
					NO. 3 SAWMILL						
Dimension I:											
6-13			4	±6	33	±9	36	±9	20	±9	7
Dimension II:											
6-11			8	±7	37	±10	45	±10	4	±5	6

[a] The following are the regression equations and related statistics for the percentage of volume produced in Construction grade lumber at the Dimension II mill from No. 2 Sawmill grade logs.

CONSTRUCTION = 12.93 + 281.73/D r^2= 0.03 $S_{y.x}$ = 0.49 CI for D = 15 inches is ±1 percent

Table 10—Average log value by diameter[a] and mill type for each log grade based on both Scribner and cubic net scales for woods-length logs

Diameter	Grade mill, No. 1 and No. 2 Peeler	Timber mill, No. 1 and No. 2 Peeler	All mills combined: No. 3 Peeler and Special Peeler	All mills combined: No. 2 Sawmill	All mills combined: No. 3 Sawmill
Inches					
	DOLLARS PER THOUSAND NET SCRIBNER SCALE				
6					401
9					422
12				468	419
15				410	406
18			425	382	388
21			425	371	367
24			425	370	
27			425	376	
30	577	470	425	387	
33-39	577	470	425		
	DOLLARS PER HUNDRED CUBIC FEET OF NET SCALE				
6					164
9					172
12				193	177
15				200	181
18			265	207	185
21			265	212	187
24			265	218	
27			265	224	
30	367	298	265	229	
33-39	367	298			

[a] Equations and related statistics are presented in table 15.

Table 11—Volume recovery[a] for all mills combined for both mill-length and woods-length logs

	Mill-length logs			Woods-length logs		
Diameter	Recovery ratio	Lumber recovery factor	Cubic recovery percent	Recovery ratio	Lumber recovery factor	Cubic recovery percent
Inches	*Percent*			*Percent*		
6	177	7	49	223	7	48
8	180	8	57	228	8	57
10	174	9	63	220	8	62
12	167	9	66	209	9	66
14	160	9	69	199	9	68
16	155	9	70	190	9	70
18	151	10	72	182	9	71
20	148	10	73	175	10	72
22	145	10	74	169	10	73
24	143	10	74	164	10	74
26	142	10	75	160	10	74
28	141	10	75	156	10	74
30	140	10	76	152	10	75
32	140	10	76	149	10	75
34	140	10	76	146	10	75
36	140	10	76	144	10	75
38	140	10	77	141	9	75
40	140	10	77	139	9	75

[a] Equations and related statistics are presented in table 13.

Table 12—Average lumber value[a] by log grade for mill-length logs for all mills combined

	Log grade			
Diameter	No. 1 and No. 2 Peeler	No. 3 Peeler and Special Peeler	No. 2 Sawmill	No. 3 Sawmill
Inches	Dollars			
6				185
9				190
12			205	191
15			208	192
18		223	213	192
21		240	218	193
24		257	224	193
27		274	230	193
30	289	291	237	193
33	329	308	243	
36	368	325	250	
39	408	342	257	
42	447	359	264	
45	487	376	271	

[a] Equations and related statistics are presented in table 14.

Table 13—Equations and statistics for estimates of volume recovery

Dependent variable and mill type	Equation	R^2	$S_{y.x}$
	MILL-LENGTH LOGS		
Recovery ratio:			
Grade	$3.05 + 2.40^*D + 2101.14/D - 5914.22/D^2$	0.15	0.25
Timber	$80.61 + 0.65^*D + 1382.77/D - 4838.49/D^2$	0.12	0.27
Dimension I	$-14.53 + 3.06^*D + 2375.89/D - 7344.65/D^2$	0.07	0.29
Dimension II	$294.18 - 4.87^*D - 976.26/D + 1782.18/D^2$	0.02	0.32
Lumber recovery factor:			
Grade	$12.06 - 0.06^*D - 29.92/D$	0.13	0.15
Timber	$11.16 - 0.001^*D - 36.10/D$	0.13	0.21
Dimension I	$12.25 - 0.04^*D - 24.02/D$	0.23	0.23
Dimension II	$7.32 + 0.20^*D - 12.99/D$	0.30	0.27
Cubic recovery percent:			
Grade	$91.96 - 0.34^*D - 228.29/D$	0.14	0.15
Timber	$86.69 - 0.02^*D - 290.57/D$	0.14	0.22
Dimension I	$87.11 - 0.19^*D - 172.84/D$	0.24	0.23
Dimension II	$44.49 + 1.81^*D - 59.83/D$	0.32	0.27
	WOODS-LENGTH LOGS		
Recovery ratio:			
Grade	$72.72 + 2382.34/D - 6724.88/D^2$	0.36	0.29
Timber	$117.73 + 1267.89/D - 3322.87/D^2$	0.09	0.28
Dimension I	$91.31 + 2382.90/D - 8452.41/D^2$	0.13	0.33
Dimension II	$179.81 + 231.64/D - 1521.83/D^2$	0.02	0.32
Lumber recovery factor:			
Grade	$11.86 - 0.06^*D - 27.60/D$	0.18	0.14
Timber	$10.84 + 0.01^*D - 31.63/D$	0.26	0.18
Dimension I	$13.07 - 0.06^*D - 28.98/D$	0.30	0.21
Dimension II	$7.69 + 0.17^*D - 16.10/D$	0.42	0.23
Cubic recovery percent:			
Grade	$90.69 - 0.40^*D - 211.65/D$	0.21	0.14
Timber	$83.87 + 0.07^*D - 251.32/D$	0.27	0.18
Dimension I	$92.14 - 0.34^*D - 204.27/D$	0.30	0.22
Dimension II	$47.86 + 1.55^*D - 86.99/D$	0.44	0.23
	MILL-LENGTH LOGS		
All mills combined:			
Recovery ratio	$63.56 + 1.05^*D + 1528.25/D - 5308.83/D^2$	0.08	0.28
LRF	$11.88 - 0.04^*D - 29.25/D$	0.17	0.22
CR%	$85.31 - 0.08^*D - 217.70/D$	0.23	0.22
	WOODS-LENGTH LOGS		
All mills combined:			
Recovery Ratio	$94.00 + 1985.72/D - 7278.53/D^2$	0.15	0.32
LRF	$11.78 - 0.04^*D - 29.37/D$	0.27	0.21
CR%	$85.97 - 0.13^*D - 222.69/D$	0.34	0.20

Table 14—Equations and statistics for average lumber value for mill-length logs by log grade and mill type

Log grade	Mill type	Equation or average and 95-percent confidence interval	R^2	$S_{y.x}$
		DOLLARS PER THOUSAND LUMBER TALLY		
No. 1 and No. 2 Peeler	Grade	434 ± 29		
	Timber	310 ± 18		
No. 3 Peeler and Special Peeler	Grade	88.25 + 7.43*D	0.31	0.22
	Timber	174.29 + 3.15*D	0.19	0.13
No. 2 Sawmill	Grade	171.45 + 2.26*D	0.13	0.16
	Timber	204.14 + 0.85*D	0.04	0.10
	Dimension I	199 ± 3		
	Dimension II	150.17 + 4.20*D	0.14	0.12
No. 3 Sawmill	Grade	178.73 ± 6		
	Timber	204.70 ± 4		
	Dimension	186.74 ± 7		
No. 1 and No. 2 Peeler	Combined	372.50 ± 23		
No. 3 Peeler and Special Peeler	Combined	120.96 + 5.66*D	0.25	0.20
No. 2 Sawmill	Combined	152.27 + 2.51(D) + 273.74/D	0.10	0.14
No. 3 Sawmill	Combined	$193.32 - 305.73/D^2$	0.01	0.15

Table 15—Log value for each log grade and mill type for woods-length logs

Log grade	Mill type	Equation or average and 95-percent confidence interval	R^2	$S_{y.x}$
		DOLLARS PER THOUSAND NET LOG SCALE		
No. 1 and No. 2 Peeler	Grade	576.78 ± 36		
	Timber	470.13 ± 33		
No. 3 Peeler and Special Peeler	All mills	424 ± 12		
No. 2 Sawmill	All mills	-92.89 + 10.15*D + 5263.55/D	0.08	0.26
No. 3 Sawmill	All mills	602.94 - 9.24*D -879.14/D	0.01	0.38
		DOLLARS PER HUNDRED CUBIC FEET NET LOG SCALE		
No. 1 and No. 2 Peeler	Grade	367.71 ± 26		
	Timber	298.30 ± 21		
No. 3 Peeler and Special Peeler	All mills	265.00 ± 8		
No. 2 Sawmill	All mills	185.66 + 1.63*D - 142.17/D	0.06	0.20
No. 3 Sawmill	All mills	198.73 + 0.19*D - 449.76/D	0.16	0.31

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This report summarizes the results of lumber recovery studies at four sawmills in western Oregon and western Washington; two dimension mills, one grade mill, and one timber mill were included. Results from individiual mills are reported and discussed. The four mills were also combined to approximate "average" conversion of logs to lumber for the region. Recovery information is presented by diameter and log grade for lumber volume, lumber grade, and lumber and log value.

Keywords: Douglas-fir, *Pseudotsuga menziesii*, lumber recovery, lumber yield, Oregon, Washington.

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